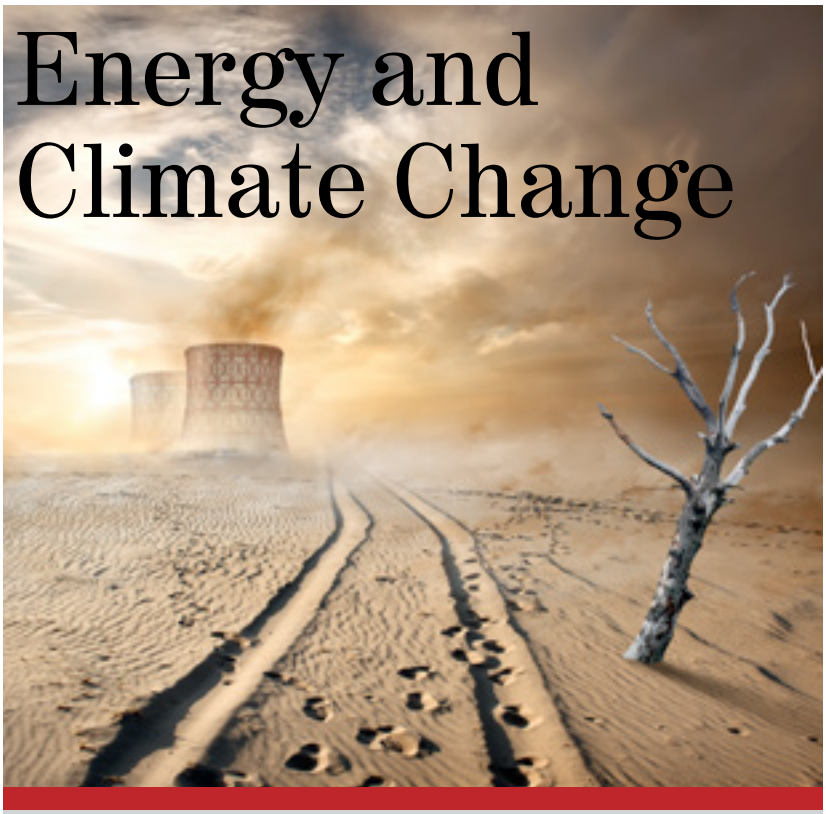
Energy and Climate Change



Unless worldwide carbon emissions are reduced, within twenty years, hundreds then thousands of people in Africa alone will die unpleasant deaths whilst a lot of land will become barren.

By Michael Prior

Readers of *The Thinker* will need little reminding as to just how serious is the problem of climate change for the future of Africa. The latest analysis suggests that if global warming only reaches the 2°C level conventionally considered reasonably 'safe' then African food production will drop by at least 10%. There has been a considerable degree of research on this topic with probably the most detailed coming from the International Food Policy Research Institute which has published three monographs on the impact of climate change on agriculture in east, west and southern Africa as well as some country specific research.[1] Such detailed work inevitably produces conclusions which are too complex to easily summarise. As the Institute's presentation at the Warsaw conference on climate change in November 2013, suggested there is *'the good, the bad and the ugly'* as in some places, particularly those with a great deal of irrigated agriculture, some impacts may actually be beneficial. In places with the 'bad and ugly' impacts (and these are the majority) African agriculture could adapt by adopting different crop varieties, increasing irrigation, even changing the whole crop balance of a region. However it will cost a great deal. A report, also presented in Warsaw, by the United Nations Environment Programme (UNEP) suggested that at least US$350 billion would be needed by 2070 if climate change moved much above the accepted target level 2°C. Even if this target was met costs of US$200 billion could be incurred.[2]

This is just the impact on agriculture based upon transition to a new stable climate regime. In the interim period, huge costs will arise from the extreme weather events – droughts, floods, storms and so on – which are an increasing feature of the African weather. A number of coastal cities will also partially disappear under the rising sea.

Greater warming would prove even more catastrophic. Yet readers will also need little warning after the debacle of the Durban climate conference (*The Thinker* February, 2012) that negotiations on a global carbon-reduction plan are moving at a glacial pace, if at all. In April, 2013 the European Emissions Trading Scheme (ETS) effectively collapsed. Introduced in 2005, the ETS was heralded as providing a market-based system for reducing carbon emissions rather than any top-down regulatory system. Under it, industries were required to purchase carbon credits to compensate for excess carbon emissions thus providing an incentive to greater efficiency. Unfortunately under business pressure, shed-loads of free permits were issued which, in times of economic recession, has led to the collapse of the price for permits to under £3/tonne when it is believed that a price closer to £30 is required to force genuine reductions. When the European Parliament rejected a plan to shore up the price, Milton Catelin, chief executive of the World Coal Association, called the European parliament vote "*a triumph of common sense and balanced policy*". Enough said.

In November, 2013, nearly 200 countries met in Warsaw on the annual jamboree known as the Conference of the Parties to the UN Climate Change Convention, this year COP 19, and, as has become wearily familiar, they essentially agreed that they would meet again next year, this time in Peru, though important negotiations have been deferred until the end of 2015 in Paris. In the first quarter of the

year, nations will be expected to put forward their planned "contributions" to cutting global emissions. These will be the centrepiece of a proposed global agreement agreed in Paris. The obviously-underwhelmed executive director of UNEP was quoted as saying *"If delegates leave here (Warsaw) with a sense of how much is left to do, then maybe that will focus efforts in the coming 12 months because without that sense we all have reason to be very concerned"*.

The main topic of the negotiations in Warsaw appears to have been a very deep-seated conflict between two groupings: those countries who wish that the distinction between developed, industrial countries and the developing world, which was embedded in the Kyoto protocols in 1997, be abolished now that China, in particular, has become the biggest global emitter; and those who wish to see the distinction maintained, arguing that, although there may be some degree of parity now in emissions, historically the developed industrial countries have contributed by far the greatest share of carbon dioxide still in the atmosphere. There are no prizes for guessing which countries belong to which camp. Whether this conflict will be patched up in Peru is very much an open question.

Just how limited have been the measures taken to reduce carbon emissions in the 20 years since climate change became officially recognised as a problem requiring global international action is shown by recent work by scientists at Lancaster University in England showing growth in long-term energy use.[3]

They estimate that growth in CO_2 emissions has been fairly constant at about 2% p.a. ever since the mid-nineteenth century and shows no signs of slowing down in the past decade. It is revealing that whilst the Great Depression of the 1930s did produce a distinct slowing in the rate of growth, the post-2008 recession has shown no comparable effect with emissions going remorselessly upwards. It is not entirely bad news as emissions in 2012 have been reported as significantly below previous years.[4] This report suggests that *"The small increase in emissions of 1.1% in 2012 (including a downward correction of 0.3% for it being a leap year), may be the first sign of a more permanent slowdown in the increase in global CO2 emissions, and ultimately of declining global emissions"*. Even so, what is needed is cuts rather than a slowdown and this remains a very distant prospect.

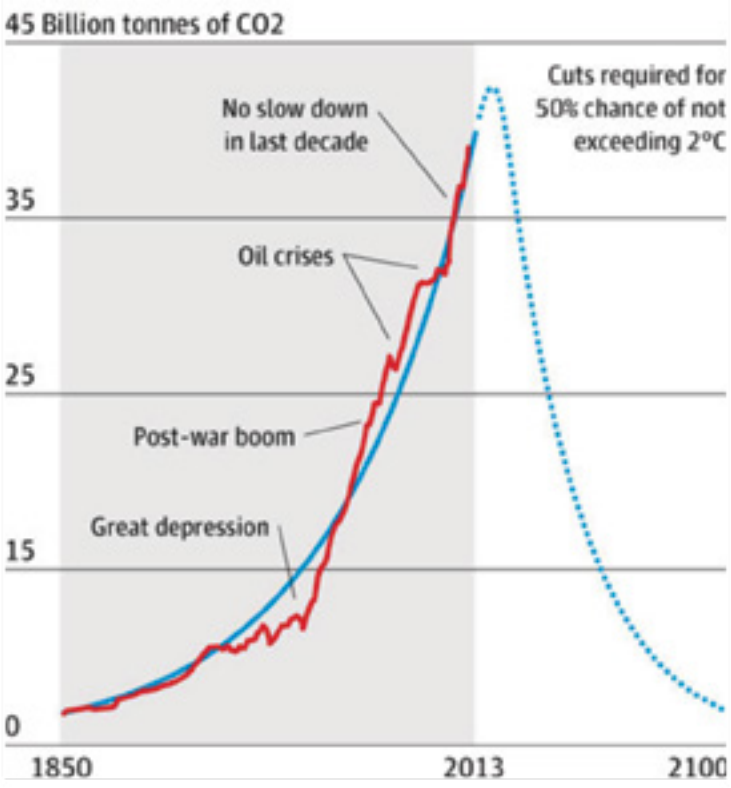


Fig 1: Annual Global CO2 Emissions since 1850
Source: Jarvis et al

An oblique look at the chances of emissions being reduced comes from a study co-authored by the Carbon Tracker think-tank and the Grantham Research Institute[5] into the valuation of energy-resource companies. This shows that *"Between 60-80% of coal, oil and gas reserves of publicly listed companies are 'unburnable' if the world is to have a chance of not exceeding global warming of 2°C"*. Yet these 'unburnable' reserves are included in the stock-market valuations of these companies and they spent $674 billion in 2012 discovering yet more potentially stranded assets. Prof. Stern, one of the authors, claims that *"Smart investors can see that investing in companies that rely solely or heavily on constantly replenishing reserves of fossil fuels is becoming a very risky decision. The report raises serious questions as to the ability of the financial system to act on industry-wide long term risk, since currently the only measure of risk is performance against industry benchmarks."* This is the optimistic conclusion. The pessimistic is that financial markets see little possibility of controls over carbon emissions and are valuing companies in this light.

Reductions in greenhouse gas (GHG) emissions whether by direct control or market-based mechanisms have always rested upon four legs: various technical solutions, energy conservation, renewable energy and nuclear power. Now that the wackier schemes have been dropped, technical solutions come down to carbon capture and storage (CCS) and electric vehicles. The latter are making steady, if slow, penetration into vehicle use in richer countries, mainly one suspects as town runabouts in two-car families, but will not make much progress in the galloping car markets of China and India. In any case, their low-carbon rating depends crucially upon

equivalent electricity which simply throws into relief the central problem of all low-carbon energy strategies: how to generate electricity.

CCS has always been the possible key technology allowing both unrestricted use of fossil-fuels in power-generation and reductions in GHG. However progress on CCS remains slow. There are essentially three approaches: post-combustion in which CO_2 is removed from exhaust gases by dissolving it in a solvent; pre-combustion in which the fossil fuel is converted into a syngas composed of hydrogen and carbon monoxide which is then burnt; and oxyfuel-combustion in which fuel is burnt in pure oxygen, in both cases giving exhaust streams of water and CO2 which are easily separated. All give rise to a final stream of CO_2 which has to be stored underground either in depleted hydrocarbon fields or deep aquifers.

The advantage of the last two approaches is that they produce purer streams of CO_2 which require, in principle, much less energy to separate. Post-combustion technology is quite well-understood but is hugely energy intensive requiring around 25% of a plant's energy. It can be retrofitted to old stations but would reduce the output of older coal-stations running at around 35% efficiency to derisory levels.

There is a big pilot scheme being built at a Canadian power station at a cost of $1.24 billion which will recover a million tonnes of CO_2 annually from an old 139 MW unit. It has the advantage that some of the cost will be recovered from using the recovered gas to produce more oil from nearby depleted fields but even so the cost is eye-watering. At the moment, it is the use of the derived gas in enhanced oil and gas recovery which drives project development mainly in the USA.

In the end, cost is the problem for CCS particularly in places which have no nearby underground storage opportunities. If translated into market terms, it would require a carbon price well above $\$50/CO_2$ to be viable, nearly twenty times above current European levels.

Energy conservation remains hugely important in GHG reduction and it is without doubt the area of quiet improvement which has done most to limit GHG emissions in the past few decades. The gradual elimination of incandescent light-bulbs, tighter building standards, the much greater fuel-efficiency of cars, improvements in efficiency of appliances, these and many other improvements have done much. However, as Fig 1 shows, by itself, energy conservation has done little to halt the inexorable rise of CHG emissions. The central problem remains the insatiable desire for electricity in most countries of the world. In Africa, electricity demand in 2012 grew by 5.3% over 2011, the largest continental increase. It would have been greater had not demand in South Africa, the continent's largest consumer actually dropped slightly. However, South African power generation, largely coal-fired, has increased from 141 TWh in 1985 to 263 TWh in 2011.[6] Other African countries show even higher growth rates whilst in the obvious example, China, generation has grown more than tenfold in the same period and shows no sign of slowing with an annual growth of 11.7% in 2011. The International Energy Agency forecasts that global electricity demand will grow by 70% by 2035.[7]

Given the central role that electrification plays in development there is no reason to doubt that such growth will continue well into the future. The issue is how to grow without generating carbon, particularly if a growth in the use of electric vehicles stimulates even greater growth. In principle, there is little problem in doing this. In the 1970s and '80s, France removed about 80% of carbon emissions from its power system with the result that French emissions peaked in 1973 at 544 million tonnes and in 2011 were down to 375 million. The practical issue is the means whereby France achieved this goal: nuclear power; and the wide-spread and visceral opposition to this power source.

At the other end of the spectrum of popular acceptability, at least in principle, are various kinds of renewable energy including wind, photovoltaics, passive solar and, though often less acceptable in practice, hydropower. This last – although the only renewable power source which has made a significant impact of global generation 16% of the total in 2011 compared to less than 2% from wind – is subject to constant environmental criticism to the extent that large dam construction has slowed to a snail's-pace in many countries. Issues of land acquisition and population displacement, together with ecological and archaeological damage have dogged many schemes. A taste of the kind of opposition can be seen in the critique of Southern African schemes by Mary Galvin, a South African activist:

> *Dam-affected communities in Southern Africa are calling for access to water, sometimes from the very dams that displaced them, for recognition of their situation, and for reparations. While there has been engagement in the [World Commission on Dams] WCD process and signs of government action, communities are generally frustrated by the failure to move past merely talking and actually respond to these calls. Yet this is far from surprising – the LHWP [Lesotho Highlands Water Project] is proceeding with more modern versions of the same damage wrought by colonial and apartheid governments. Problem-ridden programmes for dam-affected communities, as well as a disregard for wider distribution and equity issues, require civil society vigilance and action... The key question is whether activists in Southern Africa can learn from social movements that have arisen around dam struggles in other parts of the world, and organise communities that are geographically and culturally isolated from one another to respond to these life-impacting issues.*[8]

The author has no intention of taking sides in this contentious issue except to note that it would be easy to find similar expressions of opposition in countries as far apart as Mexico and India, whilst in the U.K., environmental opposition to the one potential large-scale hydro project in the country, the Severn Barrage, has stalled its development for decades.

In Africa, the potential for hydro-power is very large but, as elsewhere, it remains contentious. For example, the so-called Renaissance dam on the

Nile in Ethiopia which will generate some 6,000 MW when completed in 2017 has raised serious concerns in Egypt about its impact upon water supply to that country. An even larger project is the Grand Inga (Fig. 2) which if fully completed would be the world's largest hydroelectric plant with more than twice the power generation of the Three Gorges Dam in China, in principle up to 40,000 MW from six separate generating stations. Situated about 50 km from the mouth of the Congo river in south-west DR Congo, it is a huge undertaking only made feasible by the participation of South Africa which has agreed to take around 2,500 MW of the 4,800 MW produced in the initial phase due to be completed in 2020. However, around 30,000 people will be displaced by the dam's lake, probably more in later phases, and there have been reports of unease about just how expensive the project will prove and how little local people will benefit. The cost of this first phase is put at US$11 billion.

The problem is that hydro-power is the one renewable source that is capable of providing steady and predictable base-load generation. Whilst wind, sun and waves are able to provide significant amounts of fluctuating generation, they all require backup fossil capacity and cannot readily touch base-load operation.

Spain and Germany, for example, probably the most successful countries in the world in developing renewable energy thanks to their abundant wind and solar, are able to generate around 10% of their total demand from these sources. There are European targets to meet 20% of total energy consumption from renewable sources by 2020 which includes a substantial contribution from biofuels in the transport sector, a now rather discredited source because of its impact on food production. In the poorer countries of the world, China has made huge efforts to increase its renewable generation particularly in the last five years and generated 78.3 TWh in 2011 or 9.1% of the world total. But this achievement rather pales beside the 4700 TWh generated by the entire system. South Africa, the largest African emitter, manages to do badly in any of these comparisons, consuming just 0.4 million tonnes of oil equivalent (mtoe) in all renewables in 2011 compared with 92.9 mtoe of coal and even 2.9 mtoe of nuclear.

Most energy analysts looking objectively at the issue would now recognise that to effectively decarbonise electricity generation worldwide by, say, 80% of its current levels will require a large contribution from nuclear power which currently provides about 12% of world supply. Yet, on current policies not only is nuclear power not going to increase in the future but it is likely to diminish. In 2011, following the Fukushima incident, the German government announced that the eight oldest nuclear plants, closed immediately after the incident, would never re-open whilst the remaining nine stations would be closed by 2022. No new plant would be built. The likely impact on German carbon emissions of this decision has been hotly debated since, but the best technical judgement is the most obvious: that much of the closed capacity will be filled by new coal-fired stations however much renewables are pushed by increasing the already large subsidies. Backing this analysis is the fact that in 2013, Germany will open 5,300 MW of coal-fired plant, the largest such increase for twenty years.

It is difficult to believe that this action by the German government, mirrored by comparable movement in Japan and by a general shift in many countries towards at least delaying nuclear development, is based upon any rational assessment of the risks of continuing to operate plants which have operated safely for some decades. What one has to look at is the ingrained hostility to nuclear power which exists in a sizeable and influential part of environmental movements in these and other, largely European, countries. The origins of this hostility lie in the confused and fractured politics of the

Fig 2: Inga dam project
Source: bbc.co.uk/news/world-africa-24856000

1970s given that up to this time nuclear power had been generally welcomed and seen as an appropriate power source for a new industrial era.

One important source was the linkage which existed between nuclear power and nuclear weapons in all the major countries (USA, UK, France and Russia) which then had lead place in developing both technologies. This linkage is exemplified by the British claim that the Calder Hall reactor, opened with much fanfare by the Queen in 1956, was the first civil nuclear power station. In fact, the primary purpose of the station was to produce plutonium for weapons just as the primary purpose of the original uranium enrichment plants was to produce weapons-grade U235. This linkage has never been entirely broken. Only Israel of the world's nuclear powers has developed nuclear weapons without also having uranium enrichment facilities. There is strong evidence, however, that Israel collaborated with apartheid South Africa in the production of nuclear weapons and South Africa did possess enrichment facilities probably associated with nuclear weapon development. The current impasse over Iran's nuclear ambitions centres around the dual role of enrichment in civil and in military use.

There is no doubt that in the 1970s, this link coupled with the strong anti-nuclear (weapons) protests of the times in Europe and, to a degree, in the USA, meant that civil nuclear power lost its aura as the clean fuel of the future and became instead a symbol of military-industrial capitalism at its worst. The central fear became one of the possible devastation of a nuclear disaster, devastation closely connected in people's minds with the known effect of nuclear weapons. This fear was deepened by the partial reactor-meltdown at the Three Mile Island plant in 1979 and finally made only too real by the catastrophe at Chernobyl in 1986 which effectively put a stop to any further nuclear development in Europe. Fig. 3 is a photograph of a model of the Chernobyl reactor after its lid blew off. The Fukushima incident in March, 2011, the only other event ever given a Level 7 or Major Incident rating by the International Atomic Energy Agency, was in some ways an echo of Chernobyl.

Fig. 3: Model of Chernobyl reactor after accident

Let's rewind a little. There have been four reported nuclear incidents with the capacity to cause widespread harm. (It is possible that there were also unreported accidents in Soviet waste-disposal sites). The first was at the British Windscale establishment in 1957. Windscale was then a purely military establishment and there was a limited release of radiation following a reactor fire caused by an unexpected surge of energy in the graphite reactor-core. The Three Mile Island incident, potentially very serious but in the event fairly harmless, was caused by an unexpected chemical reaction, in this case between high-temperature water and the uranium fuel-rods which caused a hydrogen cap to form above the reactors following a stuck valve in the cooling system. Chernobyl, the only incident which caused immediate loss of life, was caused by an unauthorised experiment by the reactor operators, most of whom died, on the graphite-moderated RMBK reactors. The subsequent fire caused a very large radiation release over a wide-area and the evacuation of thousands of people from land much of which remains off-limits. At Fukushima, the critical problem following an earthquake and subsequent tsunami was that the backup generators necessary to supply power for cooling water circulation after grid failure were located, inexplicably for a seaside plant, in low-lying rooms and were flooded in the tsunami. As a consequence, three of reactors were exposed, caught fire and caused hydrogen explosions which released large amounts of radiation. No people were directly killed by this (though several plant workers were killed in the initial tsunami) but there are likely to be increased cancers in some of the exposed population. In total, 31 immediate deaths in 56 years plus an unknown number of associated cancers, certainly hundreds in the case of Chernobyl though probably much lower in the other three incidents. (In passing, it should be noted that most of those who died at Chernobyl were the very courageous fire-fighters).

Is it relevant to compare this record with, say, just major incidents in South African coal mines alone? 417 deaths in 1960 at Coalbrook North colliery; 64 deaths in 1983 at Hlobane Colliery; 53 deaths in 1993 at Middelbult colliery, a total of 534 in 53 years. In 2012, there were 18 deaths, a kind of continuing background noise. Or is a comparison with the most important renewable resource, hydropower relevant? In 1975, the Banqiao Reservoir Dam in China collapsed killing some 26,000 people directly after Typhoon Nina dropped huge amounts of rain on the region. In this and associated dam failures, an estimated 171,000 people died, 11 million people lost their homes and there was the sudden loss of 18 GW of power capacity. Dam collapses are not unusual nor are

deaths associated with these though not usually on the scale of Banqiao. They are even on YouTube.[9]

Well, probably not. In public perception, coal-mining is a 'dangerous job' where death is seen as part of normal business whilst dam collapse is one of those things which 'just happen' usually because of abnormal weather. Yet memories, even inherited, of looking down into the fires of hell at Chernobyl just will not go away or be put into the category of stuff which happens. There is, after all, the correction perception that one of the impacts of nuclear release could be some level of accelerated cancer cases, maybe small, maybe not, plus the issue of long-term land sterilisation. Yet throw into this mix, the certainty, not possibility, that, unless worldwide carbon emissions are reduced, within twenty years, hundreds then thousands of people in Africa alone will die unpleasant deaths whilst a lot of land will become barren then the balance of perception really ought to change. Will it? As things stand probably not unless there is some strong political leadership. And at the moment, governments in countries such as Germany and Japan are running scared of existing hostility to nuclear power and are, at the same time, refusing to face up to the urgency of reaching some international agreement on a programme of GHG reductions. At the moment, South Africa is the only African country in which nuclear power is a realistic option to fossil-generation but it is all African countries that will suffer unless other nations act.

The fact is that even if there were to be immediately a big push for new nuclear plant, it would hardly begin to have an impact before 2020 and even later if the retirement of old nuclear plant, much of which approaches 40 years-old, is taken into account. Nor is there now any real chance of a new international treaty to limit CHG being implemented before 2020 given that the most optimistic assessment is that it could be agreed in 2015.

The International Energy Agency, recognising both the inevitability of these time-lags and also the fact that *"Climate change has quite frankly slipped to the back burner of policy priorities"*[10] as well as the urgency of some action to reduce CHG, has published a four-point plan the for actions which could be undertaken without too much investment. It calls this a 4-for-2°C Scenario, in which four energy policies are selected that can deliver significant emissions reductions by 2020, relying only on existing technologies and have already been adopted successfully in several countries. In this 4-for-2°C Scenario, global energy-related greenhouse-gas emissions are 8% (3.1 Gt CO2 equivalent) lower in 2020 than the level otherwise expected on existing policies.[11]

They include:

- Targeted energy efficiency measures in buildings, industry and transport account for nearly half the emissions reduction in 2020, with the additional investment required being more than offset by reduced spending on fuel bills.
- Limiting the construction and use of the least-efficient coal-fired power plants which deliver more than 20% of the emissions reduction and helps curb local air pollution. The share of power generation from renewables increases (from around 20% today to 27% in 2020), as does that from natural gas.
- Actions to halve expected methane (a potent greenhouse gas) releases into the atmosphere from the upstream oil and gas industry in 2020 provide 18% of the savings.
- Implementing a partial phase-out of fossil fuel consumption subsidies accounts for 12% of the reduction in emissions and supports efficiency efforts.

Perhaps the most important of these in some parts of Africa, particularly the south and especially in South Africa, much the largest emitter of CHG on the continent, is the future use of natural gas along with more use of the renewables in which to date its progress has been less than convincing. It already imports a little gas from Mozambique and there have been major new discoveries there. In 2012, Michael Bagraim, president of the Cape Chamber of Commerce said *"The significance for South Africa is that these discoveries should wipe the nuclear option off the table. We now have enough gas on our borders to generate all the electricity we could ever use. It will be the easy way to reduce our carbon emissions"*.[12] In addition, South Africa is believed to have substantial shale gas reserves in the Karoo Basin, with technically accessible reserves well in excess of 1 trillion cubic metres.[13] With current consumption below 7 billion cubic metres annually, there is clearly a lot of headroom for growth from both sources. There are both environmental and water-resource issues about shale-gas production but in 2012 the government cleared the way for it despite these concerns by lifting a moratorium on development.

However not many countries are sitting on top of a gas bonanza. In any case, although increased gas use, particularly if it replaces coal, may limit carbon emissions, it will not decarbonise power generation in the same way as nuclear can.

It is a reluctant conclusion. The author helped organise the expert opposition to the major nuclear-power projects in the U.K. in the 1980s and still recognises the negative sides of the industry. But in the face of growing evidence for the direct and immediate harm of climate change, there is really little alternative to its global development and, in Africa, for South Africa to regard it as a serious option alongside increased use of natural gas. ■

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